

CLAIMS

What is claimed is:

1. A solar converter apparatus for converting incoming light to electricity, comprising:
 - a) a support structure for floating on a liquid bath, the structure having:
 - i) a substantially fixed relationship to an incoming light axis that is parallel to useful incoming light,
 - ii) an elevation rotation axis at a fixed azimuth alignment angle from the incoming light axis, the support structure being rotatable about the elevation rotation axis, and
 - iii) guidance interface features connecting the support structure to a guidance frame that aligns the elevation rotation axis at the fixed azimuth alignment angle to an azimuth of the source of incoming light, and that provide a rotation reference for the support structure rotation about the elevation rotation axis to align the incoming light axis with the source of incoming light;
 - b) at least one photovoltaic conversion device mounted within the support structure and adapted for converting concentrated sunlight into electricity; and
 - c) a lens coupled to the support structure for guiding light that is parallel to the incoming light axis and is received over a receiving region toward a conversion device that is mounted within the support structure, the conversion device having an active area that is smaller than an area of the receiving region.
2. The apparatus of Claim 1, wherein (d) the liquid bath is a coolant that provides primary cooling of the conversion device through thermal contact with an exterior of the support structure.
3. The apparatus of Claim 1, wherein (d) the support structure is a first support structure, and is disposed in contact with a liquid bath in an array of support structures, substantially abutting adjacent support structures that each have an elevation rotation axis parallel to and in a plane with the elevation rotation axis of the first support structure.
4. The apparatus of Claim 1, wherein (d) light parallel to the incoming light axis that enters with uniform density across an entire surface of the lens exits the lens at angles with respect to the incoming light axis, an average of all such exiting light angles defining a light delivery axis, the light delivery axis having a significant non-zero angle with respect to the incoming light axis.
5. The apparatus of Claim 1, wherein the receiving region of the lens is subject to shadowing that causes substantially non-uniform illumination of the receiving region of the lens, the apparatus further comprising

(d) a shadow toleration mechanism that coordinates light entering through the lens with each target photovoltaic conversion device to avoid substantially non-uniform illumination of operating photovoltaic conversion devices due to such shadowing.

6. The apparatus of Claim 1, further comprising (d) a plurality of subregions of the lens that each receive light substantially parallel to the incoming light axis over a corresponding receiving subregion, wherein each subregion is configured to disperse the received light substantially uniformly over an entire surface of at least one corresponding target photovoltaic conversion device.

7. The apparatus of Claim 1, wherein during operation the incoming light axis is aligned with a light source elevation angle, and the support structure floats in a coolant bath that has an average surface plane, the apparatus further comprising (d) a device mounting site within the support structure, upon which a photovoltaic converter device is mounted, which during operation is below the coolant bath average surface plane for all light source elevation angles within 45 degrees from vertical.

8. A method of collecting incoming light for conversion to electricity, comprising:

- a) mounting a conversion device at a mounting site within a support structure having an elevation rotation axis;
- b) coupling a lens to the support structure to concentrate and guide incident light arriving parallel to an incoming light axis toward the conversion device;
- c) floating the support structure on a liquid bath;
- d) aligning the support structure so that the elevation rotation axis is at an azimuth alignment angle with respect to a source of light energy; and
- e) rotating the support structure about the elevation rotation axis to align the incoming light axis toward the source of light energy.

9. The method of Claim 8, further comprising (f) cooling the conversion device primarily through thermal contact between the liquid bath and an exterior of the support structure.

10. The method of Claim 8, wherein the support structure, lens and conversion device are part of a first collection pontoon, further comprising (f) substantially abutting the first collection pontoon in an array with adjacent collection pontoons that each have an elevation rotation axis parallel to and in a plane with the elevation rotation axis of the support structure of the first collection pontoon.

11. The method of Claim 8, wherein a light delivery axis is defined as a line that intersects the incoming light axis at a center of the lens and has an angle with respect to the incoming light axis that is equal to an

average angle of light exiting the lens when such light entered the lens parallel to the incoming light axis and uniformly distributed over an entire surface of the lens, the method further comprising (f) configuring the lens to have the light delivery axis at a significantly non-zero angle with respect to the incoming light axis.

12. The method of Claim 8, wherein the lens has a light receiving region, further comprising (f) incorporating into the receiving region a multiplicity of receiving subregions that each receive light arriving parallel to the incoming light axis, and that each disperse such received light substantially uniformly over an entire surface of a target conversion device.

13. The method of Claim 8 wherein the liquid bath is a coolant bath having an average surface plane, the method further comprising (f) positioning the conversion device mounting site below the coolant bath average surface plane for all light source elevation angles within 45 degrees from vertical.

14. The method of Claim 8, further comprising incorporating a light source direction sensor within each pontoon.

15. A lens device for directing light to a solar energy collection device, the lens device comprising an overall light-receiving region configured to receive incident light along predefined paths, the overall light-receiving region including a plurality of light-receiving subregions that each receive incoming subregion light with a predefined relative density distribution along predefined paths, wherein each subregion is configured to disperse the incoming subregion light with substantially uniform density over an entirety of a corresponding finite energy collection target region.

16. The lens device of Claim 15, wherein the predefined paths for received light are all substantially parallel to a single received-light axis, and the predefined relative density distribution of the received light for each subregion is substantial equality over an entirety of the subregion.

17. The lens device of Claim 15, wherein the lens is a secondary lens configured to receive light incident to a first portion of the lens that is substantially non-parallel to light received incident to a different second portion of the lens.

18. The lens device of Claim 15, wherein each subregion has borders that are substantially parallel to a corresponding border of the energy collection target region.

19. The lens device of Claim 15, wherein each subregion further comprises a plurality of different subsubregions that are each configured to direct light arriving along an expected path toward a corresponding different subtarget that is a portion less than a whole of the energy collection target region.
20. The lens device of Claim 19, wherein two different subsubregions that are not adjacent in a length direction direct light to two different corresponding subtargets that are adjacent in the length direction.
21. The lens device of Claim 15, wherein each subregion further comprises a plurality of discontinuous subsubregions configured to direct expected incident light toward a specific common subtarget that is a portion less than a whole of the energy collection target region.
22. The lens device of Claim 15, wherein each subregion is a tile, and adjacent tiles are offset from each other with respect to an expected shadow line.
23. The lens device of Claim 15, wherein each subregion is a tile, and each tile includes a plurality of Fresnel facets.
24. The lens device of Claim 15, wherein each subregion is a tile having a length that is L_T times a length of the energy collection target region and a width that is W_T times a width of the energy collection target region, and L_T is not equal to W_T .
25. The lens device of Claim 15, wherein each subregion is a tile having a length that is L_T times a length of the energy collection target region and a width that is W_T times a width of the energy collection target region, and
- a) L_T for one tile is unequal to L_T for another tile, or
 - b) W_T for one tile is unequal to W_T for another tile.
26. The lens device of Claim 15, wherein each subregion is a tile having a width that is W_T times a width of the energy collection target region, W_T is less than unity, and light entering each subregion in parallel diverges such that the light is distributed substantially uniformly across a full corresponding greater width of the energy collection target region.
27. A method of directing light to a solar energy collection device to reduce inefficiencies caused by shadowing a portion of an overall light receiving region that is configured to direct such light to a solar energy collection device target, the method comprising:

- a) configuring a lens to direct light incident on an overall light-receiving region toward a solar energy collection device target region having a finite extent that is substantially smaller than the overall light-receiving region;
- b) configuring a plurality of light-receiving subregions of the overall light-receiving region to each individually receive light along expected paths with an expected relative intensity distribution over such subregion; and
- c) configuring each of the light-receiving subregions to disperse such received light with substantially uniform density over substantially an entirety of the solar energy collection device target region.

28. The method of Claim 27, wherein the lens is configured to receive light substantially parallel to an incoming light axis over the overall light-receiving region, the expected paths for each subregion are substantially parallel to the incoming light axis, and the expected relative intensity distribution over each subregion is substantially uniform.

29. The method of Claim 27, wherein step (b) further comprises configuring each subregion to have borders that are substantially parallel to a corresponding border of the energy collection device target.

30. The method of Claim 27, further comprising:

- d) establishing a multiplicity of different subsubregions within each subregion, and
- e) configuring each of the subsubregions to direct light incident thereon, following the expected path for the corresponding subregion, toward a corresponding different specific subtarget that is a portion less than a whole of the energy collection device target.

31. The method of Claim 27, further comprising:

- d) establishing a multiplicity of discontinuous subsubregions within each subregion, and
- e) configuring each of the subsubregions to direct light incident thereon, following the expected path for the corresponding subregion, toward a corresponding common specific subtarget that is a portion less than a whole of the energy collection device target.

32. The method of Claim 27, further comprising creating each subregion as a tile composed of a plurality of Fresnel facets.

33. The method of Claim 27, wherein the lens is a secondary lens, further comprising disposing a primary lens between the secondary lens and a source of solar energy.